Semi axis major ... = 102 astronomical units.
Combined mass ... = 6·5 sun's mass.
Parallax ... ... = 0″·0197.
Velocity of system in line of sight ... = − 5·18 g.m. (23·88 Eng. miles) per sec.

The investigation is one of such delicacy that considerable uncertainty remains as to the data deduced; but the individual results appear to be sufficiently consistent to warrant the publication of the foregoing provisional values. The results are especially interesting as being the first practical outcome of a suggestion first made by Fox-Talbot in 1871, and developed mathematically by Dr. Rambaut and Dr. See (NATURE, vol. liii. p. 15).

A CATALOGUE OF FOURTH-TYPE STARS.—The Rev. T. E. Espin has recently revised his valuable catalogue of stars of the fourth type (Group VI.) which are at present known, including stars discovered at Harvard and Arequipa, and not before published (*Monthly Notices*, vol. lviii. p. 443). The following summary shows the distribution of the stars in magnitude and in the two hemispheres, the magnitudes of variable stars being entered according to their maxima:—

Mag.	N.	S.	Total.
to 6·0	3	4	7
6·1 ,, 7·0	12	11	23
7·1 ,, 8·0	19	20	39
8·1 ,, 9·0	51	25	76
Below 9·0	69	11	80
Mag. not given	1	11	12
Total ...	155	82	237

It is considered probable that our knowledge of the number of stars of this type is complete for the northern heavens as far as 8·9, and for the southern heavens as far as 8·5. The catalogue contains twenty-eight variables to which letters have been assigned, twenty-two being north and six south. "It would appear that almost all the stars of Type IV. are subject to fluctuations in brightness, though the red colour makes it not easy to decide when the variation is small."

A YORKSHIRE MOOR.[1]

II.

THE Bilberry (or Blueberry, as we ought to call it) is one of the few exceptions to the rule that moorland plants are evergreen; it casts its leaves in early winter. But the younger stems are green, and take upon themselves the function of leaves, when these are absent. Kerner has described one adaptation of the Bilberry to seasons when water is scarce. Many plants, especially those of hot and wet climates, throw off the rain-water from their tips, and so keep the roots comparatively dry; others direct the water down the branches and stem to the roots. Bilberry is one of the latter sort. The rounded leaves slope downwards towards the leaf-stalk, and from the base of every leaf-stalk starts a pair of grooves, which are sunk in the surface of the stem. A light summer shower is economised by the guiding of the drops towards the roots. Bilberry abounds on the loose and sandy tracts of the moor, and especially on its verges; it is seldom found upon a deep bed of peat.

There is a moorland plant which may be said to mimic the heaths, as a Euphorbia mimics a Cactus, or Sarracenia a Nepenthes. Similarity of habit has brought about similarity of structure. The plant I mean is the Crowberry, which is so like a true heath in its foliage and manner of growth, that even the botanists, who did not fail to remark that the flowers are altogether different, long tried to bring the Crowberry and the heaths as near together in their systems as they could. Crowberry has the long, dry, wiry stems, the small, narrow, rolled, clustered, evergreen leaves of a true heath. The leaf-margins are turned back till they almost meet, and the narrow cleft between them is obstructed by close-set hairs, so that the transpiring surface is effectually sheltered. Crowberry is a peat-loving shrub, and is often found with ling and other heaths in the heart of the moor. The berries are a favourite food of birds, which help to disseminate the species. Crowberry has an uncommonly wide distribution, not only in the Arctic and Alpine regions of the Old World, but also in the New. It abounds in Greenland, where the Eskimo use the berries as food, and extract a spirit from them. A very similar species, with red berries, occurs in the Andes.

The heaths, Bilberry, Crowberry, and many other peat-loving shrubs or trees, have a peculiar root-structure. The usual root-hairs are wanting, and in their place we find a peculiar fungus-growth, which invades the living tissues of the root, sometimes penetrating the cells. There is often a dense mycelial mantle of interwoven filaments, which covers all the finer roots. This looks like parasitism, but the fungus is apparently not a mere parasite, for the tree or shrub shows no sign of injury, but thrives all the better when the fungus is plentiful, and may refuse to grow at all if the fungus is removed. Rhododendron, Ling, most heaths, Bilberry, Crowberry, Broom, Spurge-laurel, Beech and Birch are among the plants which have a mycelial mantle.

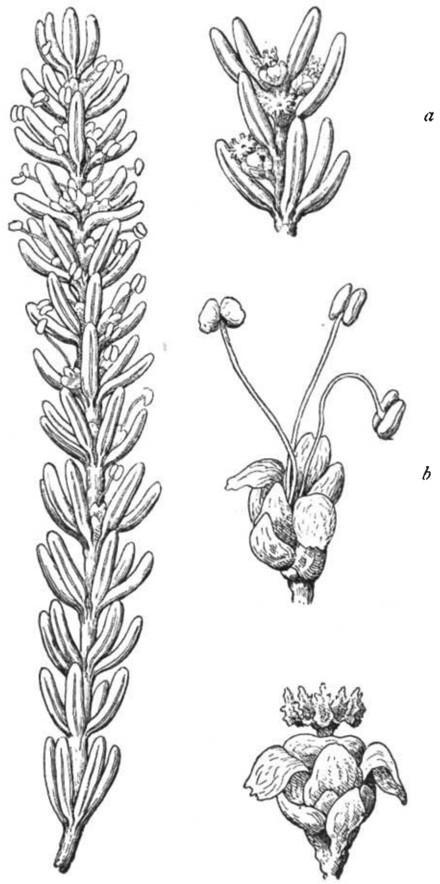

FIG. 7.—Crowberry (*Empetrum nigrum*). A staminate branch, slightly enlarged; *a*, part of a pistillate branch; *b*, one staminate flower; *c*, one pistillate flower.

If the native soil which clings to the roots of any of these is completely removed, if the fine roots with the mycelial mantle are torn off by careless transplanting, or if peaty matter is withheld, the plant dies, or struggles on with great difficulty until the mycelial mantle is renewed. Such plants cannot, as a rule, be propagated by cuttings, unless special precautions are taken. Frank maintains that the mycelial mantle is the chief means of absorption from the peaty soil, and that the tree or shrub has come to depend upon it. The known facts render this interpretation probable, but thorough investigation is still required. In some cases at least the plant can be gradually inured to the absence of a mycelial mantle. I have repeatedly planted crowberry in a soil devoid of peat. It generally succumbs, but when it survives the first year, it maintains itself and slowly spreads. Microscopic examination shows that the roots of crowberry grown without peat contain no mycelial filaments or very few.

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[1] A discourse given at the Royal Institution, February 1898. By Prof. L. C. Miall, F.R.S. Continued from p. 380.

The special function of the fungus may be to reduce the peat to a form capable of absorption as food by green plants. It is likely that the fungus gains protection or some other distinct advantage from the partnership. Most of the species of green plants which have the mycelial mantle are social. It is obvious that the fungus will be more easily propagated from plant to plant, where many trees or shrubs of the same species grow together.

The grasses of the moor are marked xerophytes, with wiry leaves, whose look and feel tell us that they have adapted themselves to drought and cold by reducing the exposed surface to a minimum. A section of the leaf of Nardus, Aira flexuosa, or Festuca ovina shows that the upper surface, which in grasses bears the stomates, is infolded, and sometimes greatly reduced. Advantage has been taken by these grasses of a structure which was apparently in the first instance a provision for close folding in the bud. The upper, stomate-bearing surface is marked by furrows with intervening ridges, and where the folding is particularly complete, both furrows and ridges are triangular in section, and the leaf, when folded up longitudinally, becomes an almost solid cylinder. In the grasses of low, damp meadows, the power of rolling up may soon be lost by the leaves. Other grasses, which are more liable to suffer from drought, retain in all stages the power of rolling up their leaves. Sesleria cærulea, for instance, which covers large tracts of the limestone hills of Yorkshire, can change in a few minutes from closed to open, or from open to closed, according to the state of the air. The leaves of the true moorland grasses (Nardus, Aira flexuosa, Festuca ovina) are permanently inrolled, and flatten out very slowly and imperfectly, even when immersed in water for many hours.

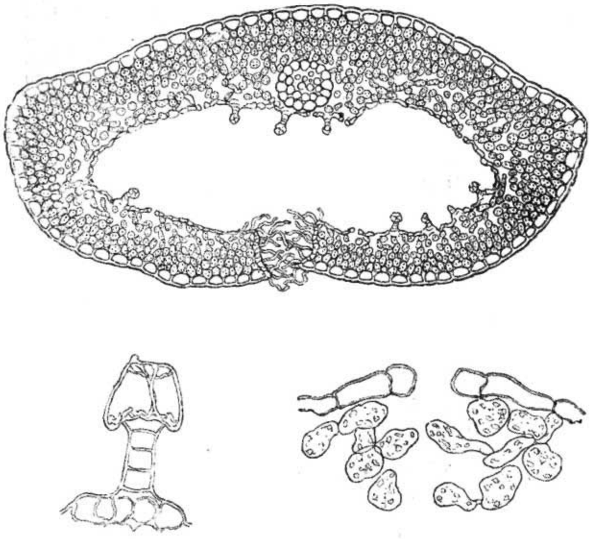

FIG. 8.—Cross-section of leaf of Crowberry. The lower figures show one of the peculiar hairs and one of the stomates. Both are confined to the inner, which is properly the under surface.

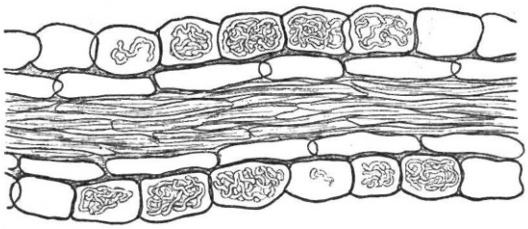

FIG. 9.—Longitudinal section of root of Ling (*Calluna vulgaris*), showing mycorhizal filaments in outer cells.

Our moorland grasses are all arctic, and occur both in the old and the new worlds; Festuca ovina is also a grass of the steppes; it is world-wide, being found in all continents, especially on mountains, and even reaching Australia and New Zealand.

It may seem paradoxical to count the Rushes as plants which are protected against drought, for they often grow in the wettest part of the moor. They are common, however, in dry and stony places, and their structure is completely xerophytic. The leaves are often reduced to small sheaths, which wither early, while the stems are green, and perform the work of assimilation; or else, as happens in certain species, the leaves assume the ordinary structure of the stem. The cylindrical form of the Rush-stem is significant, for of all elongate solid figures the cylinder exposes the smallest surface in proportion to its volume. Moreover a cylindrical stem, without offstanding leaves, and alike on all sides, is well suited, as Jungner points out, to the circumpolar light, which shines at low angles from every quarter in succession. A Rush-stem is singularly dry, the centre being occupied by an abundant pith of star-shaped cells, which entangle much air.

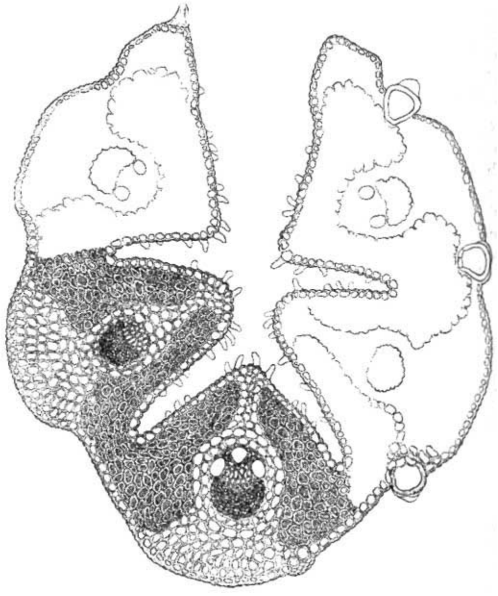

FIG. 10.—Transverse section of leaf of *Nardus stricta*, showing permanent in-rolling.

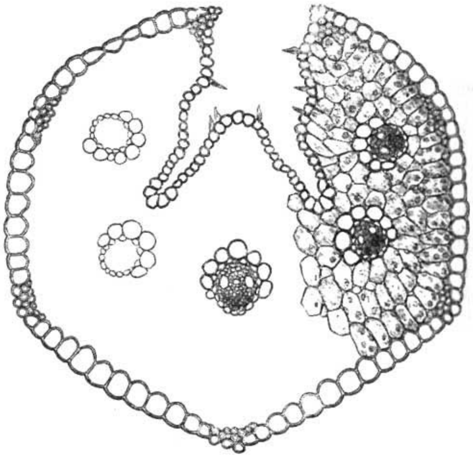

FIG. 11.—Transverse section of leaf of *Aira flexuosa*.

The Hair-moss (Polytrichum commune) of the moor has a defence against sun and wind, which has been described by Kerner. The leaf has wings, like an altar-piece, which can open and shut. The assimilating surface occupies the centre, and rises into many green columns. In wet or cloudy weather the wings open wide, but when the sun shines they fold over the columns, and protect them from scorching.

All the most characteristic plants of the moors are Arctic. Ling, bilberry, crowberry, certain rushes, Nardus, Festuca ovina, most of our club-mosses, the hair-moss, and Sphagnum range within the Arctic Circle; while the large flowered Heaths get close up to it. Most of them are found on both sides of the Atlantic, and some, like the crowberry and Festuca ovina, have a singularly wide distribution.

It has often been pointed out that great elevation above sea-level produces a similar effect upon the flora to that of high latitude. In the Alps, the Pyrenees, the Himalayas, and even in the Andes, the forms characteristic of northern lands re-appear, or are represented by allied species. Where, as in the case of the Andes, nearly all the species differ, it is hard to draw useful conclusions, but whenever the very same species occur across a wide interval the case is instructive. In the Alps we find our moorland and arctic flora almost complete, though Rubus Chamæmorus, Erica Tetralix, and E. cinerea (both found in the Pyrenees), Narthecium ossifragum and Aira flexuosa have disappeared.

A favourite explanation rests upon the changes of climate to which the glaciation of the northern hemisphere bears emphatic witness. When the plains of Northern Europe were being strewn with travelled boulders, when Norway, Scotland, and Canada were covered with moving ice, the vegetation of Siberia and Greenland may well have extended as far south as Switzerland.

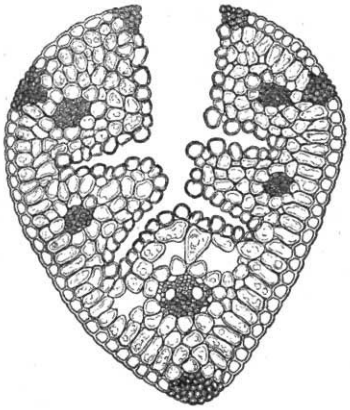

FIG. 12.—Transverse section of leaf of *Festuca ovina.* In thick sections hairs are seen to point inwards from the inner epidermis.

I do not doubt the general truth of what we are taught respecting the glacial period, but I think that we are apt to explain too much by its help. We know very little for certain as to its effect upon vegetation. Our information concerning the preglacial flora is extremely meagre, nor are we in a position to say positively what sort of flora covered the plains of Europe after the severity of glacial cold had passed away, and before men had changed the face of the land by tillage.[1] We know rather more about the animals of these ages, for animals leave more recognisable remains than plants, but the indications of date, even in the case of animals, are apt to be slight and uncertain. On the whole, I doubt whether the glacial period marks any great and lasting change in the life of the northern hemisphere.[2] I think it probable that since the glacial period passed away the countries of Central Europe possessed many species both of plants and animals which we should now conconsider to be Arctic, and that these Arctic species endured until many of them were driven out by an agent of which geologists usually take little notice. I shall come back to this point.

The animal life of the Yorkshire moors is not abundant. Hares, shrews, stoats, weasels, and other small quadrupeds, which are plentiful on the rough pastures, cease where the heather begins. There are a good many birds, some of which, like the grouse, the ring-ouzel, the twite, or mountain-linnet, the curlew, and the golden plover, seek all their food on the moor, except in the depth of winter, when some of them may visit the sea-coast, or the cultivated fields, or even southern countries. The kestrel, blackbird, whinchat, stonechat, night-jar, and lapwing abound on the "roughs" or border-pastures rather than on the moor itself. Owing to the absence of tarns and lochs there are practically no waterfowl. Gulls are hardly ever seen, though they are common enough on the Northumberland moors. Now that the peregrine, golden eagle, and hen-harrier are exterminated, the chief moorland birds of prey are the merlin, kestrel, and sparrowhawk. Of these only the merlin is met with in the wilder parts of the moor, where it flies down the smaller birds. The kestrel hovers over the roughs, on the look-out for a mouse or a frog. The sparrow-hawk preys upon small birds, but rarely enters the heart of the moor.

To most people the interest of the moor centres in the grouse. There are many things about grouse which provoke discussion, such as its feeding times, or the grouse-fly, and what becomes of it during the months when the grouse are free of it. But the absorbing topic, on which every dweller by the moor is expected to have an opinion, is the grouse-disease.

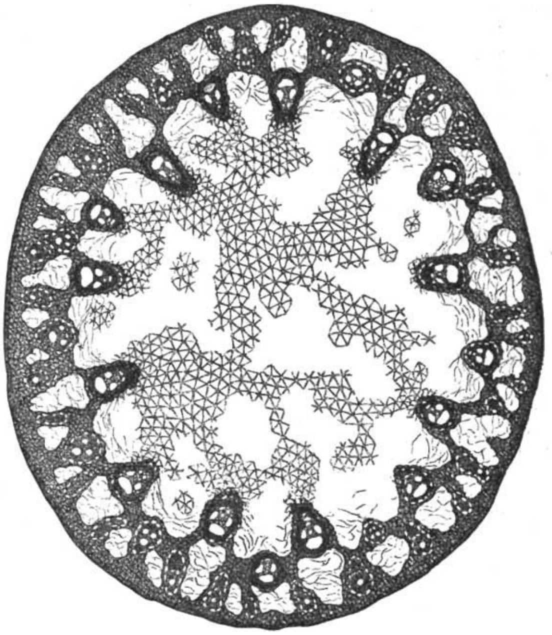

FIG. 13.—Transverse section of stem of Rush (*Juncus conglomeratus*), showing the stellate pith-cells, and very numerous air-spaces.

All sorts of causes have been assigned, such as over-stocking of the moors, destruction of the large hawks which used to kill off ailing birds, parasitic worms, cold, deficiency of food, and so on. Some Yorkshire sportsmen have attributed the disease to the scarcity of gritty sand. On shale-moors, they maintain, the gizzard of the grouse is filled with soft stones, which will not grind up the heather-tops effectively, except when they are young and tender. On sandstone moors the grouse can deal with tougher food, and there the disease, it is said, is unknown. Dr. Klein's researches[1] show that the disease is really due to the multiplication within the body of a specific germ, which is fungal, but not bacterial. The infection is conveyed, or may be conveyed, by the air.

The viper is rare, and until quite lately I had never heard of its presence on our Yorkshire moors. Lizards are also rare, but efts are not uncommon. Among the moorland moths are many small Tineina (allied to the clothes-moth). The caterpillar of the emperor moth is characteristic, and seems to be protectively coloured, for it wears the livery of the heather—green and pink,

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[1] Some information has been gained by investigation of plant-remains found beneath the bogs of Denmark, and beneath the palæolithic brick-earth at Hoxne.

[2] It is well known that this position has been strongly maintained by Prof. Boyd Dawkins ("Early Man in Britain," p. 123, &c., *Q. J. Géol. Soc.*, vol. xxxv., p. 727, and vol. xxxvi., p. 399). On the other side, Dr. James Geikie may be consulted ("Prehistoric Europe," ch. iii., &c.).

[1] "The Etiology and Pathology of Grouse Disease, &c." (1892).

The moths which issue from these larvæ are captured in great numbers by Sunday ramblers, who resort to the base contrivance of bringing a female moth in a cage. The self-styled "naturalist" sits on a rock, and captures one by one the eager moths which come about him, afterwards pinning out the expanded wings to form grotesque patterns, or selling his specimens to the dealers. Certain wide-spread Diptera are plentiful, and there are a few which pass their larval stages in the quick-running streams which flow down from the moor. The small number of good-sized insects partly explains (or is explained by) the paucity of conspicuous scented or honey-bearing flowers. In this the moor contrasts strongly with the higher Alps. Bees, however, get much honey from the large-flowered heaths and ling; heather-honey is considered better than any other. A little scale-insect (*Orthesia uva*) has been found plentifully on the Sphagnum of the moors, particularly in Cumberland.[1] A big spider (*Epeira diadema*) spreads its snare among the heather, and may now and then be seen to deal in a particularly artful fashion with a wasp or other large insect which may have blundered into the web. The spider cuts the threads away till the struggling insect dangles; cautiously on outstretched leg holds out and attaches a new thread, and then sets the wasp spinning. The silken thread, paid out from the spinneret, soon binds the victim into a helpless mummy.[2] I have never found gossamer so abundant as on the verges of the moor.

In our day the Yorkshire moor harbours no quadrupeds, and the grassy hills none but small quadrupeds. It was not always so. At Raygill, a few miles from us across the moors, a collection of bones was discovered a few years ago in quarrying. A deep fissure in the rock had been choked ages before with stones and clay. This fissure was cut across by the working face of the quarry. Many bones were brought out of it, bones of the ox and roebuck among the rest. But mixed up with these were teeth and bones of quadrupeds now altogether extinct or no longer found in Britain, such as the straight-tusked elephant (*E. antiquus*), the hippopotamus, a southern rhinoceros (*R. leptorhinus*), the cave hyæna, and the European bison. The Irish elk is often dug up in Yorkshire, the reindeer and the true elk now and then. Not very long ago these and other large quadrupeds grazed or hunted a country which can now show no quadruped bigger than a fox.

It is evident that the moors, valleys and plains of Yorkshire have been depopulated in comparatively recent times. The disappearance of so many conspicuous species is commonly attributed to the glacial period, but I think that the action of man has been still more influential. The extinct animals are such as man hunts for profit or for his own safety. Many of them, among others the cave-bear, Machairodus, Irish elk, mammoth, and straight-tusked elephant, are known to have lasted into the human period. That so many of them were last seen in the company of man is some proof that he was concerned in their death.

Central Europe, before man appeared within its borders, or while men were still few, little resembled the Europe which we know. Much of it was covered with woods, morasses or wastes, and inhabited by animals and plants, of which some ranged into the Arctic circle, others to the Mediterranean, Africa and India. The worst lands of all—cold, wet, and wind-swept—had doubtless then, as now, the greatest proportion of Arctic species. But it is likely that the passage from the bleak hills to the more fertile valleys and plains was not then so abrupt as at present. All was alike undrained and unenclosed; and what we know of the distribution of life in Pleistocene Europe shows us that a large proportion of our European animals and plants are not restricted by nature within narrow limits of latitude or climate. Species which are now isolated, at least in Central Europe, occupying moors or other special tracts, and surrounded by a population with which they have little in common, were formerly continuous over vast areas. In the early days of man in Europe many plants, birds, and quadrupeds which are now almost xclusively Arctic may well have ranged over nearly the whole of Europe.

As men gradually rooted themselves in what are now the most populous countries of the world, the fauna and flora underwent sweeping changes. The forests were cleared, and trees of imported species planted here and there. The land was drained, and fenced, and tilled. During the long attack of man upon wild nature many quadrupeds, a few birds, some insects, and some plants are known to have perished altogether. Others have probably disappeared without notice. Certain large and formidable quadrupeds, though they still survive, are no longer found in Europe, but only in the deserts of the south or the unpeopled northern wastes. Thus the lion, which within the historic period ranged over Greece and Syria, and the grizzly bear, which was once an inhabitant of Yorkshire, have disappeared from every part of Europe. Tillage and fencing have checked the seasonal migrations of the reindeer and the lemming. Useful animals have been imported, chiefly from the south or from Asia. Useful plants have been introduced from ancient centres of civilisation, and common farm-weeds have managed to come in along with them. Many species of both kinds are southern, many eastern, none are Arctic. In our day the cultivated lands of Europe are largely occupied by southern or eastern forms, and the wastes appear by contrast with the imported population more Arctic than they really are. Even the wastes are shrinking visibly. The fens are nearly gone, and we shall soon have only a few scattered moors left to show what sort of vegetation covered a great part of Europe in the days of choked rivers and unfenced land. The moors themselves cannot resist the determined attack of civilised man. Thousands of acres which used to grow heather are now pastures or meadows.

What we call the Arctic fauna and flora of to-day is apparently only the remnant of an assemblage of species varying in hardiness, which once extended from the Arctic circle almost to the Mediterranean. If climate and soil alone entered into the question, it is likely that the so-called Arctic fauna and flora might still maintain itself in many parts of Central Europe. This Arctic (or ancient European) flora includes many plants which are capable of withstanding extreme physical conditions. Some thrive both on peat and on sand, in bogs and on loose gravel. They may range from sea-level to a height of several thousand feet. They can endure a summer glare which blisters the skin, and also the sharpest cold known upon this planet. Some can subsist on soil which contains no ordinary ingredient of plant-food in appreciable quantity. Such plants survive in particular places, even in Britain, less because of peculiarly appropriate surroundings, or of anything which the microscope reveals, than because they can live where other plants perish. Ling, crowberry, and the rest are like the Eskimo, who dwell in the far north, not because they choose cold and hunger and gloom, but because there only can they escape the competition of more gifted races. The last defences of the old flora are now being broken down; it is slowly giving way to the social grasses, the weeds of commerce, and the broad-leaved herbs of the meadow, pasture, and hedge-row. The scale has been turned, as I think, not so much by climatic or geographical changes, as by the acts of man.

Every lover of the moors would be glad to know that they bid fair to be handed down to our children and our children's children without diminution or impoverishment. The reclaiming of the moors is now checked, though not arrested, and some large tracts are reserved as open spaces. But the impoverishment of the moors goes on apace. The gamekeeper's gun destroys much. Enemies yet more deadly are the collectors who call themselves naturalists, and the dealers who serve them. A botanical exchange club has lately exterminated the yellow Gagea, which used to grow within a mile of my house. Whenever a kingfisher shows itself, young men come from the towns eager to slay it in the name of science. No knowledge worth having is brought to us by such naturalists as these; their collecting means mere destruction, or at most the compilation of some dismal list. If the selfish love of possessing takes hold of any man, let him gratify it by collecting postage-stamps, and not make hay of our plants and mummies of our animals. The naturalist should aspire to study live nature, and should make it his boast that he leaves as much behind him as he found.

THE MARINE FAUNA IN LAKE TANGANYIKA, AND THE ADVISABILITY OF FURTHER EXPLORATION IN THE GREAT AFRICAN LAKES.

THERE is a story which redounds to the sagacity of a certain Dutch farmer, who, on the sudden appearance of herrings in the ditches on his property, sold it, on account of the indisputable evidence which such fish afforded, of the leaky condition of the dykes. The Dutchman's inference will serve to

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[1] Shaw (1806), quoted by R. Blanchard in *Ann. Soc. Ent. Fr.*, tom. lxv. p. 681 (1896).

[2] Blackwall's "Spiders," vol. ii. p 359.